Conversion of Elbow Arthrodesis to Total Elbow Arthroplasty: A Case Report and Literature Review

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Abstract

Elbow arthrodesis is a salvage operation designed to relieve pain and enable weight bearing in young patients with painful arthritic joints who have failed all other treatment modalities. Unfortunately, elbow arthrodesis is poorly tolerated by many patients because there is no fusion position that accommodates all activities of daily living. As indications for elbow arthroplasty expand and implant design improves, patients living with elbow arthrodesis may seek conversion to arthroplasty to regain a functional range of motion. Only one case of elbow arthrodesis to elbow arthroplasty conversion has been reported in the English literature to date. We present the case of a 58 year old male, five years status post elbow arthrodesis, unable to perform his ADLs adequately, who was successfully converted to a total elbow arthroplasty. Indications, contraindications, and technical pearls are discussed.

Keywords

elbow arthroplasty, elbow arthrodesis, revision elbow arthroplasty

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Introduction

Arthrodesis of the elbow is a salvage procedure utilized when other attempts at elbow reconstruction have failed to alleviate pain, instability, or infection.[1,2] Although elbow arthrodesis can provide pain relief and stability, the motion loss associated with this procedure can be an obstacle to performing activities of daily living (ADL).[1–4] In young patients with significant requirements for upper extremity weight bearing, this may be a reasonable option.

Elbow arthroplasty is another option for treatment of a painful arthritic elbow. It offers the advantage of maintaining active joint range of motion, but necessitates lifetime weight bearing restrictions to mitigate the risk of loosening. Total elbow arthroplasty (TEA) was initially indicated for patients with rheumatoid arthritis, but indications have expanded in recent years to include post-traumatic arthritis and distal humerus fractures with good outcomes.[5] Elbow arthroplasty is typically avoided in younger patients due to the increased demands on the elbow and concerns that the patient will outlive the implant.

There may be a role for conversion of elbow arthrodesis to TEA as the patient with an elbow fusion ages and the benefits of active elbow range of motion outweigh the limitations of weight bearing restrictions. Conversion from fusion to TEA is a rare procedure that has been described in only one case in the English literature to date[6] and one case in the German literature.[7] Below we present the case of an elbow arthrodesis successfully converted to TEA in a middle-aged male patient to improve his ability to perform activities of daily living.

Case

The patient is a 58-year-old right hand dominant male electrician who was involved in a workers' compensation injury 5 years prior in which he suffered a terrible triad injury to the

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left elbow. He was treated with open reduction and internal fixation and radial head replacement at an outside hospital. He developed a deep infection of the elbow 1 year later with cultures positive for Enterobacter cloacae. He underwent hardware removal, irrigation and debridement, 6 weeks of oral ciprofloxacin, and ultimately elbow fusion. He subsequently suffered a fracture of the ulna just distal to his fusion plate, which was managed non-operatively in a splint, leaving a deformity of the ulnar shaft.

Four years after elbow fusion (Figure 1), he was not satisfied with his elbow function and presented to the senior author (T.G.S.) to address this. He complained of difficulty with activities of daily living and work-related tasks due to his elbow immobility. He specifically reported difficulty with tying his shoes and putting on his belt. On physical exam the patient had healed posterior and lateral elbow scars. He was non-tender about the elbow and had excellent contractility of the biceps, brachialis and triceps muscles as well as distally in the wrist and hand. He had normal sensibility and perfusion of the hand. The patient was offered a fusion takedown and total elbow arthroplasty with the goal of increasing range of motion and elbow function. The patient was counseled at length on the lifetime weight bearing restriction of 10 pounds following TEA.

In order to be a candidate for conversion to TEA, a patient must (1) have retained muscle function to power flexion and extension[5,8] and (2) be agreeable to a lifetime 5 to 10 pound weight bearing limit. The biceps, brachialis, and triceps muscles must have good contractility in order to power active motion at the elbow and confer stability to the elbow. Contraindications to conversion elbow arthroplasty include soft tissue compromise and active infection elsewhere in the body – such as the skin, oral cavity or feet. The patient in the case presented had been successfully treated for a deep infection of the elbow 4 years prior and had no fevers, chills, swelling or redness about the elbow. If there is any concern for persistent infection, preoperative white blood cell count, C-reactive protein, and sedimentation rate, as well as elbow aspiration and intraoperative cultures should be performed. Patients with extensive scarring, burns, or prior graft coverage over the elbow are at increased risk. Conversion to TEA should only be considered if the soft tissues can be adequately addressed with flap coverage at the time of surgery.

Preoperatively, there are several considerations to ensuring success in the operating room. The surgeon may anticipate there to be extensive scarring about the ulnar nerve requiring a careful neurolysis. To address soft tissue contractures and achieve acceptable range of motion postoperatively, additional distal humerus bone may need to be resected at the time of surgery. Considering the many variables at play when converting to TEA, preoperative planning is critical to ensure that the appropriate implants, along with tools to modify them intraoperatively, are available.

The patient was taken to the operating room where he underwent hardware removal, osteotomy, and conversion to total elbow arthroplasty with a linked, long stemmed, cemented implant without radial head replacement (Tornier Latitude EV, Wright Medical Group, Middlesex, United Kingdom). The patient was positioned supine with an ipsilateral shoulder bump and the arm draped across the chest. A posterior midline triceps splitting approach was performed, incorporating existing scars. The incision was carried directly down onto the posterior humerus and extended onto the dorsal ulna distally. The ulnar nerve is identified proximally and a careful neurolysis was performed to protect and later transpose the nerve (Figure 2). All hardware was removed from the elbow. The ulna and humerus were divided with an osteotomy, and additional bone was resected to permit full extension and flexion of the elbow after arthroplasty. Contraction over time will prevent full extension if this step is not performed.

A bur was used to open the canal of the humerus and ulna and a guide rod and reamers were used to open the canals to the appropriate size. In this case, a biplanar closing wedge osteotomy of the ulnar shaft was required to correct the preexisting ulnar deformity and accommodate the TEA implant. A long-stemmed implant was selected to cross the osteotomy site by 2 cortical diameters and autograft from the distal humerus bone was packed into the osteotomy site to promote union. Trialing was performed ensure full flexion and extension were achieved, and the implants were then cemented in position and held in full extension while the cement hardened. Antibiotic impregnated cement was used to mitigate the risk of prosthetic joint infection. Immediate postoperative radiographs are shown in Figure 3.

The triceps split was repaired with 2.0 non-absorbable suture tape interwoven in a running fashion from the proximal aspect of the split in the tendon down to the proximal ulna where the suture is secured through bone tunnels with the arm in extension. A suture with large tapered needles on either end was used for triceps closure so that the needles can be straightened and passed through the olecranon bone tunnels simultaneously to avoid any risk of cutting one limb with passage of the other. After skin closure, a bulky dressing and anterior splint were placed to maintain the elbow immobile in full extension for 2 weeks.

The patient was transitioned to a hinged elbow brace at 2 weeks postoperatively, and the flexion arc was advanced 30 degrees every 2 weeks until full range of motion was achieved. The patient was permitted to use the arm for feeding and dressing starting at 6 weeks. At 3 month follow up, the patient had achieved 5 to 105 degrees of active flexion (Figure 4). Supination was limited to 5 degrees due to development of heterotopic ossification (HO) at the ulnar osteotomy site (Figure 5). The senior author does not routinely perform HO prophylaxis for primary or revision TEA surgery, however prophylaxis with indomethacin or postoperative radiation can be considered. Once the HO was stable on serial radiographs, the patient was taken for excision of HO at 8 months. Bone

Figure 1. Radiographs of the elbow after arthrodesis.

was excised using a bur and osteotome, followed by thorough irrigation and interposition of gel foam to prevent recurrence. At 10 months the patient achieved 60 degrees supination and active elbow flexion from 5 to 115. The patient was happy with his ability to perform ADLs, including reaching the back of his head and feeding himself, and he required no further pain medications.

Discussion

Elbow conversion arthroplasty is rare. Only 2 cases of elbow arthrodesis to TEA exist in the literature.[6,7] This surgery may be indicated more commonly in the future with technological advances in TEA and as surgeons become more facile with TEA. Elbow arthrodesis, while still an important salvage procedure for younger higher demand patients, may compromise a patients' ability to perform ADLs, particularly when he or she lacks full function of the contralateral limb. The functional range of motion of the elbow is 30 to 130 degrees. In extension, the elbow is most useful for personal hygiene, and work-related activities. In flexion, the elbow enables feeding, dental hygiene, and many activities of daily living.[2] With this in mind, fusing in the most commonly used position of 90 degrees of flexion ensures that the elbow will perform poorly for both personal hygiene and feeding activities. The alternative would be to fuse in either extension or flexion and forgo the other position and activity entirely with that arm. In a patient with bilateral upper extremity injuries the issue is compounded further. If lack of elbow motion compromises quality of life and function to a significant degree, the risk of TEA loosening over time may be outweighed, and conversion to TEA may be considered.

Lessons on converting to TEA can be gleaned from the work of Peden and Morrey,[8] who reported on 13 cases of ankylosed elbows converted to TEA. They achieved a mean elbow range of motion of 37 to 118 degrees flexion, and 10 of 13 patients were satisfied with their outcome. They caution that a high rate of complications was seen, including reoperation in over half of patients, 5 cases of heterotopic ossification, 3 infections, and 1 case of aseptic loosening. Our early results of elbow arthrodesis to arthroplasty conversion are similar to those of Rog and Burkkart. Rog et al reported on the only existing elbow arthrodesis to arthroplasty conversion in the English literature.[6] A 49-year-old male with fusion 31 years prior was converted to TEA and achieved an elbow flexion-extension arc of 0–110 degrees at 4.5 months. No complications were reported. A second case report identified in the German literature by Burkkart et al reports the outcome of a 44-year-old male who underwent elbow fusion 7 years prior and was converted to TEA.[7] At 9 months postoperatively he achieved an elbow flexion-extension arc of 25–110 degrees. No complications were reported.

A patient with a history of elbow fusion may be a candidate for conversion to arthroplasty if the lack of elbow range of motion has become unacceptable to him or her. Commonly, fusion is pursued as a salvage procedure when the ability to bear weight is crucial to a patient's profession or lifestyle. As these patients age and their demands change, the weight-bearing limit of an elbow arthroplasty may become an acceptable trade-off for improved elbow range of motion. Patients

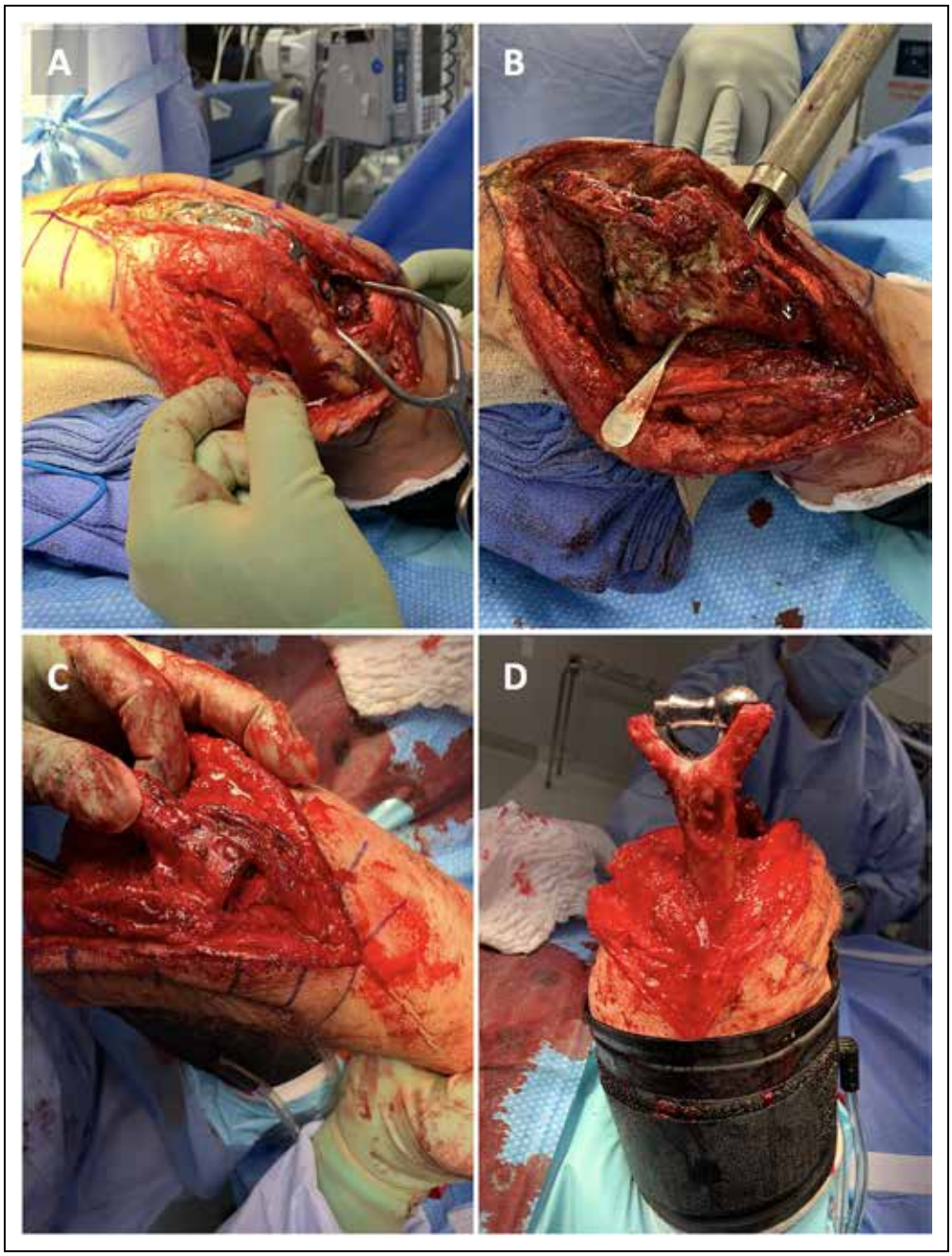

Figure 2. Intraoperative photographs. (A) Ulnar nerve dissected from scar tissue and protected. (B) Triceps splitting approach and plate removal. (C) Corrective ulnar osteotomy to accommodate prosthesis. (D) Humeral bone preparation and trial implant.

need to understand this important trade-off before undergoing surgery. If the muscle function to power elbow flexion and extension is compromised, conversion to total elbow arthroplasty should not be pursued.

In preparation for converting fused elbow to TEA, the surgeon must consider how to address bony deformities, soft tissue coverage, and the risk of injury to neurovascular structures encased in scar tissue. In the case presented an ulnar osteotomy was required to straighten the intramedullary canal and accommodate an ulnar prosthesis. A similar ulnar osteotomy was required in the case presented by Rog et al.[6] Soft tissue expanders may be used preoperatively to address a deficient soft tissue envelope, and wound vacuums or soft tissue flap coverage may be necessary postoperatively.[5,9] Existing scars should be incorporated into the surgical dissection and skin bridges less than 7 cm avoided to prevent skin break down. The ulnar nerve must be identified, protected, and transposed anteriorly to permit full extension of the elbow.

Although complications rates after conversion to TEA are unknown, the procedure is expected to have a high rate of

Figure 3. Immediate postoperative radiographs after conversion to total elbow arthroplasty.

Figure 4. Clinical photographs demonstrating active elbow range of motion 3 months postoperatively.

complications based on primary TEA, revision TEA, and anklyosed elbow to TEA conversion.[5,8,10,11] The rate of revision after primary total elbow arthroplasty is 13%.[12] Due to limited soft tissue envelope, primary TEA is associated with a high rate of infection estimated at 3–8%.[10,11,13,14] Other modes of failure include: aseptic loosening (up to 15%), periprosthetic fracture

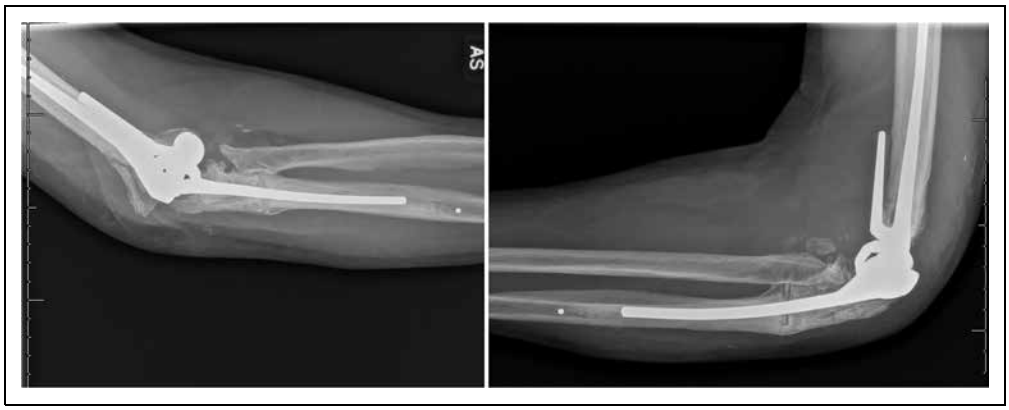

Figure 5. Radiographs of the elbow 8 months postoperatively showing healed ulnar osteotomy and heterotopic ossification formation.

(5%), component failure (bushing wear up to 15%), and instability.[5,12] In a multiply operated elbow, the risk of wound dehiscence, breakdown, and infection increase considerably. Instability in the setting of poor soft tissue and bone stock remains a challenge, although this has been mitigated by linked implant designs. Heterotopic ossification, stiffness and nerve injury are also common complications in revision elbow surgery.[5,8] A thorough discussion with the patient preoperatively about these risks is essential.

Conclusion

We present the case of a 58-year-old male electrician successfully converted from elbow fusion to total elbow arthroplasty due to the unacceptable limitations of elbow fusion for his daily life. This is the second case of conversion from fusion to elbow arthroplasty in the English literature, and it may be instructive to surgeons managing patients unsatisfied with their own elbow fusions. With careful consideration to the pitfalls, indications, and contraindications to conversion, this procedure may be a good option for patients who are willing to trade weight bearing limitations for elbow range of motion.

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Ethical Approval

Not applicable, because this article does not contain any studies with human or animal subjects.

Informed Consent

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Trial Registration

Not applicable, because this article does not contain any clinical trials.

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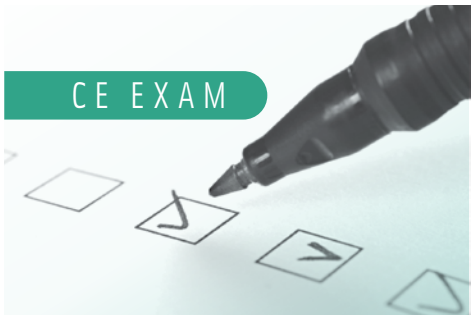

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1. **Elbow arthroplasty is another option for treatment of a painful arthritic elbow.**
a. True
b. False

2. **In order to be a candidate for conversion to TEA, a patient must be agreeable to a lifetime ___ weight bearing limit.**
a. 1-4 pounds
b. 5-10 pounds
c. 11-15 pounds
d. 16-20 pounds

3. **In the case study featured in the article, the patient was placed in the ____ position.**
a. Lateral
b. Prone
c. Supine
d. Lithotomy

4. **A ___ was used to open the canal of the humerus and ulna.**
a. Guide rode
b. Bur
c. Reamers
d. All of the above

5. **Conversion to TEA should only be considered if the ___ can be adequately addressed at the time of surgery.**
a. Hardware removal
b. Osteotomy
c. Excessive scarring
d. Soft tissues

6. **During this case study, the flexion arc was advanced ____ every 2 weeks until full range of motion was achieved.**
a. 15 degrees
b. 20 degrees
c. 25 degrees
d. 30 degrees

7. **To address soft tissue contractures and achieve acceptable range of motion postoperatively, additional ____ bone may need to be resected at the time of surgery.**
a. Distal humerus
b. Distal ulna
c. Distal radius
d. Humerus

8. **For this case, supination was limited to ____ due to development of heterotopic ossification at the ulnar osteotomy site.**
a. 3 degrees
b. 4 degrees
c. 5 degrees
d. 6 degrees

9. **During the procedure, a long-stemmed implant was selected to cross the osteotomy site by ___ cortical diameters.**
a. 1
b. 2
c. 3
d. 4

10. **Which procedure incision was performed directly after the patient was in position?**
a. Posterior humerus splitting approach
b. Dorsal ulna distally splitting approach
c. Posterior midline triceps splitting approach
d. Dorsal ulna lateral splitting approach

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